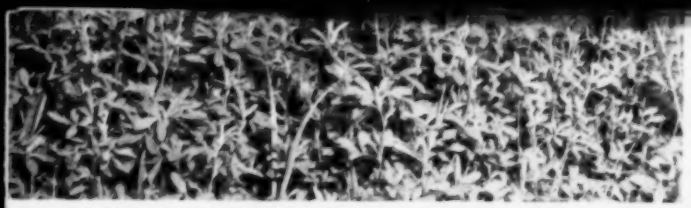

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Pasture Improvement and Management

BY
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Pasture Improvement and Management

W. K. Kennedy

When Cato, the Roman philosopher, was asked over 2000 years ago what was the most profitable thing a farmer could have, he replied, "A first-class pasture". Somewhat startled, his questioners then asked what the second most prized possession would be. "A second-class pasture," was his ready reply.—W. E. Adams. *What's New in Crop and Soils,* Feb. 1950.

A good pasture is one of the finest assets a New York livestock farmer can have. A dairy cow can obtain enough nutrients from top quality pasture to maintain herself and produce up to 40 pounds of milk per day without additional feed. Pasture is the cheapest source of livestock feed.

In spite of the value of good pasture, much of the grazing land in New York State produces feed for only 6 to 8 weeks in the spring and then becomes unproductive for the remainder of the year. Proper liming and fertilization, better seeding mixtures, and careful management will triple the production of many pastures. Recommendations for pasture improvement and management are discussed in this bulletin.

Type of Land to Improve

The best land available for pasture should be improved first. Not more than one-half acre of seeded pasture or one acre of permanent pasture should be improved for each cow or cow-equivalent unless the excess spring growth can be harvested as hay or silage. On many farms when the better pasture land is in top production, the poorer land may not be needed. A good pasture will produce from two to four tons of hay-equivalent per acre.

When selecting fields for pasture improvement, consideration should be given to: (1) soil type, (2) distance from the farm buildings, (3) accessibility of drinking water, and (4) suitability for division into smaller paddocks for rotational grazing. If possible fields should be selected that can be included in a rotation with cultivated and small grain crops so that periodic plowing and reseeding can be practiced. If the pasture to be improved is unsuitable for

Figure 1.—***Rough land.*** **Improve better land first. "The best land available for pasture should be improved first."**

other crops, steps should be taken to free it from stones, stumps, and hummocks so that close mowing will be possible.

Type of Pasture

The carrying capacity of many pastures can be doubled by the use of enough lime and fertilizer along with good grazing management. Kentucky bluegrass and white clover will soon replace the less productive grasses and weeds on most soils when a fertilizer and pasture clipping program is followed. While much better than unimproved pastures, such pastures produce little feed in midsummer. For best results pastures should be reseeded with mixtures that will provide more summer forage. Suitability of the soil for plowing, its depth, moisture-supplying capacity, and internal drainage determine what forage crops can be used.

The latest recommendations for forage crop varieties and mixtures are listed in *Hay and Pasture Seedings*, Cornell Extension Bulletin 781, which is revised annually. Consult the most recent issue of this publication before purchasing the seed for a new pasture. All local seed and fertilizer dealers also have the latest Cornell recommendations.

If the pasture cannot be included in a regular crop rotation because of steep slopes, stoniness, poor drainage, or location on the farm, a long-lived legume is needed. Empire birdsfoot trefoil is first choice because it is long-lived, will withstand either close or infrequent grazing, and is adapted to a wide range of soil conditions. No other legume has sufficient longevity to be used in this

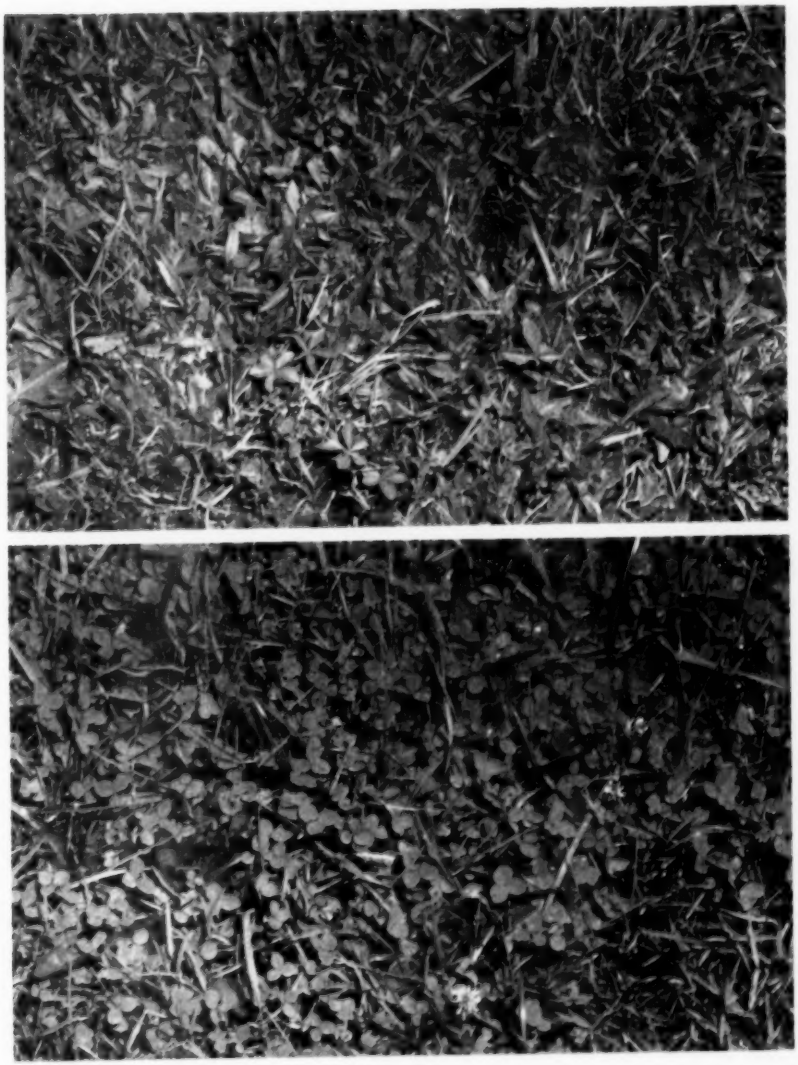


Figure 2.—*Improved permanent pasture.*

Top: An unimproved native pasture which consists mostly of broadleaf weeds and unproductive grasses.

Bottom: A similar area as above after adequate liming and fertilization. The weeds have been largely replaced by Kentucky bluegrass and wild white clover.

Figure 3.—*Empire birdsfoot trefoil pasture.* For pastures where careful management is not possible because of location on the farm, steep slopes, stoniness, or poor drainage, Empire birdsfoot trefoil is the best legume.

situation. Timothy is the grass usually sown with Empire birdsfoot trefoil.

For land which is moderately well to somewhat poorly drained and which can be included in a crop rotation program, either ladino clover-grass or European birdsfoot trefoil-grass mixtures are recommended. Ladino clover is excellent on land that is well supplied with moisture throughout the growing season. Ladino clover may last only two to four years and should not be used for long-term stands. It performs reasonably well under continuous grazing if sown with smooth bromegrass but must be rotationally grazed if sown with a competitive species like orchard grass. Alfalfa can be included in this mixture unless the drainage is uniformly poor.

The upright broadleaf or European birdsfoot trefoil is superior to ladino clover if the land is droughty or where the area will remain in pasture for longer than four years. Since this legume grows upright, it will not withstand continuous grazing. The pasture must be divided into smaller paddocks and rotational grazing practiced. For pasture, bromegrass is superior to timothy as the associated grass. Orchard grass is too competitive and is not recommended with birdsfoot trefoil.

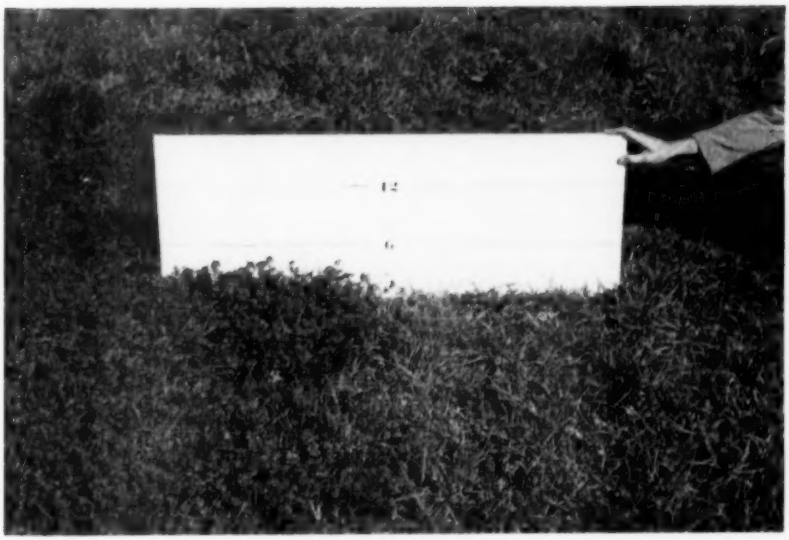


Figure 4.—*Regrowth of European and Empire types of birdsfoot trefoil.* The European type birdsfoot trefoil (left) grows more erect and recovers faster after cutting than the Empire type (right). European birdsfoot trefoil in pastures must be managed the same as alfalfa.

Alfalfa-grass mixtures are the most productive for soils that are well drained to moderately well drained. If alfalfa is the only legume, the pasture must be rotationally grazed for short periods and allowed to reach a height of at least 10 to 12 inches between grazings. When the pasture is to be left down more than two years, is is desirable to allow the alfalfa to reach the hay stage at least once each year. The inclusion of ladino clover is desirable in fields that are to be used solely for grazing. The inclusion of European type trefoil, instead of ladino, is desirable for fields of marginal or spotty drainage and which are to remain in pasture for more than two years. The associated grass can be orchard grass, smooth bromegrass, or timothy. Orchard grass will produce the most early spring, midsummer, and late fall growth but becomes unpalatable as it matures. Smooth bromegrass is easier to manage than orchard grass but is less productive. Timothy is somewhat lower yielding than orchard grass or bromegrass especially after the first harvest or grazing and is therefore third choice as a grass in alfalfa-grass seedings.

Figure 5.—*Alfalfa-bromegrass pasture.* Alfalfa-grass is the most productive pasture mixture; however, soil conditions must be good and the pasture carefully managed.

Need for Lime

Buying expensive seed and fertilizer is a waste of money if the soil remains too acid. The lime requirement can be determined by checking the pH of the soil with a Cornell Soil Test Kit or through a test by the county agricultural agent. All parts of the field, not just the near corner, should be tested. The tables in the bulletin in the Soil Test Kit can be used to determine how much ground limestone should be applied for the legume to be seeded. Alfalfa requires a pH of 6.5 or above, while other legumes will do reasonably well if the pH is kept above 6.0.

When large applications of lime are needed, it is best to apply some of the lime before plowing and the remainder after plowing. If a moderate amount of lime is used, it should always be applied after plowing so that it will be concentrated near the seed in the top two or three inches of the soil. Even when liberal amounts of lime are applied, some lime should be applied after the soil is plowed.

Once the soil has been limed to the desired pH, maintenance applications of about 1 ton of lime per acre are required every 4 to 5 years.

Figure 6.—*Lime on alfalfa.* The fields above were prepared and seeded exactly alike except the area on the right received four tons of lime and the area on the left was unlimed. The soil pH must be 6.5 or above for alfalfa.

Establishing the Pasture

Seedbed preparation

When possible, the existing sod should be plowed and the area planted to a cultivated crop for one year. This kills the old sod, allows it to decay, and cleans the land of many weeds which would otherwise seriously compete with the new seeding. A cultivated crop the year before seeding is especially desirable when ladino clover or birdsfoot trefoil are seeded. A year of cultivation also results in a firmer seedbed than can be prepared by renovation without plowing. After the cultivated crop, the field may be plowed and fitted, or if the soil is loose and friable harrowing alone may be adequate.

On steep, stony, or wet land a cultivated crop may not be practical. However, plowing is more effective in killing the old sod than bush and bog harrows or field cultivators which cut up the sod but do not turn it under. Chemical grass-killers (see Cornell Extension Bulletin 821, *Chemical Weed Control,* revised annually) plus summer tillage may be substituted for plowing on steep or stony sites. Whatever method of tillage is used, it is necessary to kill the old sod to obtain good legume establishment. Special precautions must be taken to firm the seedbed when plowing is not possible.

Seeding the pasture

If the pasture is part of a crop rotation, the seeding is usually made in a small grain. The method of seeding depends upon the kind of small grain, the legumes and grasses to be

seeded, and the equipment available. Spring grains and the forage grasses and legumes are usually sown in one operation or, if in separate operations, within a day or two of each other. A grain drill with a forage seed box attachment is excellent for legumes and timothy but one precaution must be taken. If the forage seed box is on the front of the drill, hose extensions must be fastened to the outlets of the seed box so that the seed of the forage crops will drop *behind* the furrow openers. If the seed drops in front of the drill, many of the seeds will be covered too deeply. Where low soil fertility is a problem, the hose extensions from the forage seed box should be extended to a point about 12 inches directly behind the furrow openers and about 2 inches above the surface of the soil. The forage seed will be dropped in rows directly over the fertilizer and small grain (figure 8). This is called *band seeding* of forage crops.

When orchard grass or bromegrass is included in the forage seeding the farmer has two alternatives: (1) sow the large seeded grass separately in a seeder equipped to handle such grasses or, (2) mix the large seeded grass thoroughly with the grain and seed as the grain is drilled. If the latter method is used, the grain must be planted shallow (not over one inch deep), and the grain and grass seed should be mixed frequently in the hopper to prevent separation.

Figure 7.—*Birdsfoot trefoil seedlings in oats.* Pastures are usually seeded with a small grain. For successful pasture seedings, management of the small grain crops should be such that it offers as little competition to the legume and grass seedlings as possible.

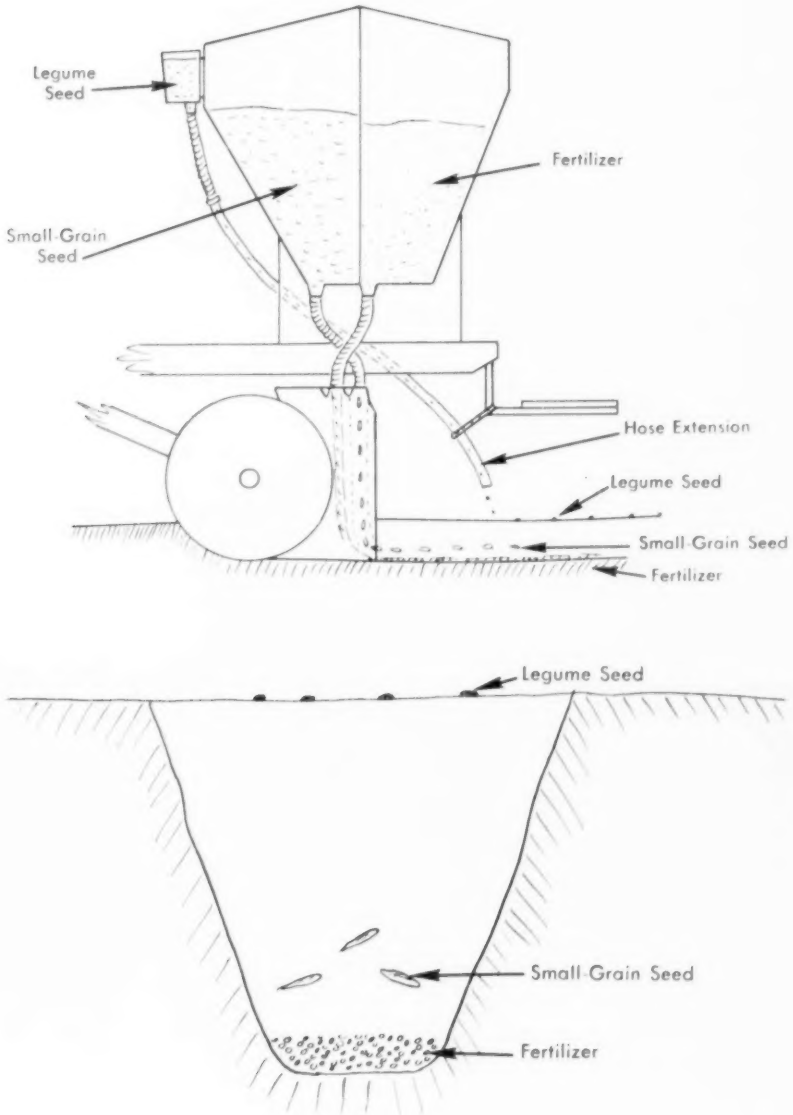


Figure 8.—*Drawing of band seeding.*

When a winter grain, such as wheat, rye, or barley is the companion crop, all of the recommended pasture or hay grasses, except orchard grass, can be sown when the grain is planted in the fall. The legumes and orchard grass must be seeded the following spring. Cyclone, horn or tractor-mounted broadcast seeders are satisfactory for early surface seedings on winter grain.

Band seeding also can be used to seed legumes in winter grain. In the spring superphosphate can be drilled into the soil and the forage seed banded directly over this fertilizer. A complete fertilizer should not be used in this situation because the seeds may come in direct contact with the fertilizer. Nitrogen and potash fertilizers placed too close to the seed may result in poor germination.

Regardless of whether the companion crop is a winter or spring grain it will compete with the young forage seedlings for moisture and nutrients. Also the tall-growing companion crop will shade the small legumes and grasses. If soil conditions are likely to be unfavorable for rapid seedling establishment, grazing the small grain or omitting it entirely may be desirable. Grazing small grains reduces their competition with the forage seeding. A good seeding usually can be obtained with wheat, barley or oats which are harvested for grain if the grain does not lodge. Liberal fertilization of the small grain with nitrogen may cause lodging and loss of seeding.

Time of seeding

Forages have relatively small seeds and lack seedling vigor when compared with small grains, corn, and other large seeded crops. The small forage seeds will not come up if covered too deeply. Since legumes must be sown on or near the soil surface the correct soil moisture is difficult to maintain, especially during the summer. One or two warm days will dry the surface soil to a point where seed germination will be stopped. Those seeds that have germinated may die because of a lack of water.

When forages are sown in small grain the seeding should be made as early as possible in the spring. Moisture conditions are usually adequate for the establishment of forage seedings in late April and early May but become less favorable as the season advances. Early seeding is particularly important for (1) red clover and ladino clover which grow vigorously only in cool weather and, (2) all spring seedings in fall-sown grain so that the legumes can get started before the fast growing grain shades them too much and competes for moisture.

Summer seeding is satisfactory for alfalfa in areas where summer rainfall is adequate. Alfalfa seedlings grow more rapidly during warm weather than red clover; alfalfa will usually survive the winter if seeded not later than August 15. Earlier seeding, as near to August 1 as possible, is preferred. A "rule of thumb" for summer seedings is to wait until

after a good rain to seed. If it does not rain, then don't seed.

In New York it is not safe to seed legumes in the fall. The young seedlings will not make enough growth to survive most winters. Timothy, smooth bromegrass and most other grasses except orchard grass and tall fescue can be sown in the autumn with winter grains. The legumes must be seeded the following spring.

Fertilizing the new seeding

For rapid seedling establishment a complete fertilizer should be used. A liberal supply of phosphorus is essential for young legumes. Small to moderate amounts of nitrogen help to get the young seedlings off to a good start early in the spring when the soil is too cold for much microbiological release of soil nitrogen. Excessive applications of nitrogen may result in too much competition between the legumes and the small grain and forage grasses. Moderate to liberal amounts of potassium are needed by the young seedling, the amount depending on the potassium-supplying power of the soil. For soils with high potash-supplying power, such as many of those in Central New York and most soils from clays, fertilizers with a 1–2–1 ratio are recommended. For all soils with medium and low potash-supplying power, such as all soils with hardpans, those from gravels, those from sands, and many high lime loamy soils, a 1–2–2 ratio is desirable. Enough fertilizer should be used to supply about 35 pounds of nitrogen, 70 pounds of phosphate, and 35 to 70 pounds of potash per acre.

If the soil has received little or no fertilizer in the past, it is highly desirable to band the seed directly over the drilled fertilizer. If this is not possible, it is desirable to increase the rate of phosphate fertilization up to at least 100 pounds of P_2O_5 per acre.

Top-dressing at the time of seeding or in the fall of the seeding year with 5 or 6 loads of farm manure per acre is beneficial to seedling establishment. The manure serves as a mulch. When applied in the spring, manure protects the young plants from drying out during the summer. When applied in the fall it insulates against frequent changes in temperature during the winter. Manure that contains seeds of serious pasture weeds, such as yellow rocket, bedstraw, or cockle should not be used unless it has been piled for at least 6 weeks. Weed seeds may be killed in well-rotted manure. Heavy applications of manure stimulate growth of grasses and may reduce the vigor and stand of legumes.

Weed control during the seedling year

Both broadleaf and grassy weeds can be extremely competitive with legume seedlings. Complete weed control in legume seedings with selective herbicides is not possible at present. New chemicals which show considerable promise are being developed, but until suitable materials

are available, special care should be taken to prepare a weed-free seedbed. (See the current issue of Cornell Extension Bulletin 821 for latest recommendations.) This is best done, as already discussed, by growing a cultivated crop, such as corn, on the land during the year prior to seeding. Weeds are reduced by cultivating and spraying the corn with herbicides. A well-fertilized crop of corn also shades the ground and serves as a smother crop for quack and other weedy grasses.

If the land is unsuitable for cultivated crops because of stoniness, wetness, or steepness of slope it may be desirable to use herbicides plus cultivation to reduce the stand of broadleaf and grassy weeds. Dalapon, TCA, Amino triazol, CMU, and 2,4-D alone and in combinations can be used for killing the vegetation on old pastures. Recommendations of the current issue of Cornell Extension Bulletin 821 should be followed.

A newly seeded pasture should be checked frequently. If a large number of broadleaf annual weeds appear, the new seeding should be sprayed with one of the dinitro chemicals. The dinitros kill by contact and must be applied while the weed seedlings are small. If the legumes are protected by a canopy of weeds and small grain the amines of 2,4-D or MCP can be used. The pressure of the spray should be kept low (30 to 40 pounds).

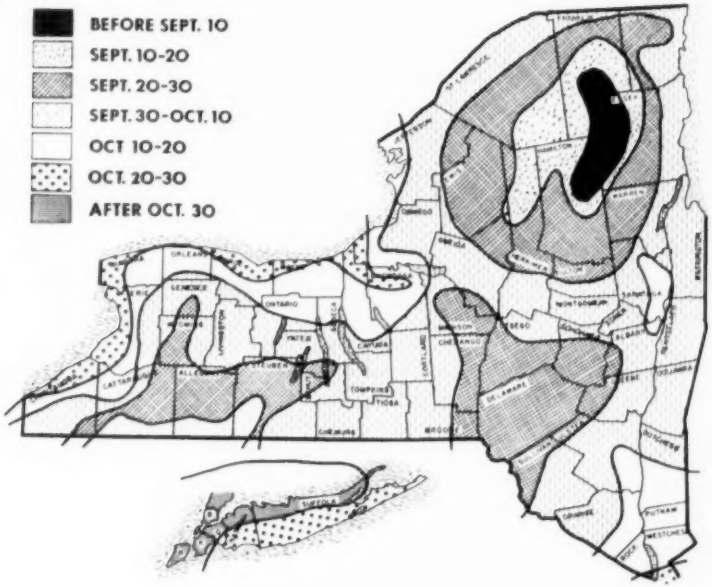
When a seeding is made without a companion crop, severe weed competition may develop. As soon as a heavy growth of weeds occurs, the seeding should be mowed. If the mowing is done early, the weeds can be left in the field. When mowing is delayed, the weed growth may become so heavy that the forage seeding will be smothered if the mowed weeds are not removed. This expensive and time-consuming operation can be avoided by mowing earlier.

Management of the new seeding

Small grain companion crops as well as weeds are competitive with young forage plants. Using a companion crop is a compromise rather than the ideal method of seeding pasture crops. On sites with good moisture and fertility conditions, a crop of grain can be produced and satisfactory seedings of the more vigorous pasture legumes and grasses can usually be obtained. When growing conditions are somewhat less than ideal, or when a legume such as birdsfoot trefoil, with poor seedling vigor is being seeded, a grain crop may be too competitive. Cutting the small grain for hay, or better still, using it for pasture will reduce the competition with the pasture seeding.

Usually pastures should not be grazed or mowed during the seeding year except for removing the small grain or weed competition. The growth of forage in very favorable seasons may be great enough that light grazing in late August may be desirable. Animals should be re-

Figure 9.—*Map of frost dates.*



moved from the new seeding 4 to 6 weeks before the average date of the first killing frost, and while there is still considerable uneaten forage (figure 9). If the grazed stubble is less than 4 to 6 inches in height when the animals are removed, the new seeding has been overgrazed. Overgrazing and late fall grazing cause many of the legume seeding failures in New York State.

Fertilizing the Established Pasture

Need for phosphorus

Most New York soils are naturally low in phosphorus, but over the years many farmers have applied considerable phosphate fertilizer by topdressing with superphosphate or by using superphosphate in the barn to fortify the manure. If the phosphorus content of the soil has been built up, there is little need to continue to apply large amounts of phosphorus. A complete fertilizer should be used when seeding to assure ample phosphorus for the young seedlings. After establishment, the amount of phosphate fertilizer required depends upon the level in the soil. The phosphorus level can be determined by sending a representative soil sample to the Cornell Soil Testing Laboratory (see your county agent for details). If the soil tests low in phosphorus at least 100 pounds of P_2O_5

should be applied to a legume-grass pasture. Future application should be based on soil tests. An application of about 100 pounds of P_2O_5 every other year or 50 pounds yearly will likely meet the needs of the crop and begin to build a soil reserve. If the soil tests high in phosphorus, the initial application of phosphorus can be cut in half, or in some cases, after the legume is well established, it may be omitted for one or two years.

Need for potassium

Many soils in New York State have good supplying power for potassium and will provide enough potassium for fair yields of forage. Few soils, however, will supply enough of this nutrient for top production of legume-grass mixtures and annual applications of potash will be required. The complete soil test is the best guide for determining how much potash should be applied annually. (See Cornell Extension Bulletin 780, revised annually, for current fertilizer recommendations.)

It is best to delay the application of potash fertilizer until after the flush spring growth, because most soils release enough potassium for the early growth of forage. On silt loam and finer textured soils, the potash can be applied in single annual applications.

On coarser textured soils the supplying power for potash usually is low and the losses of added potash are relatively high. For maximum

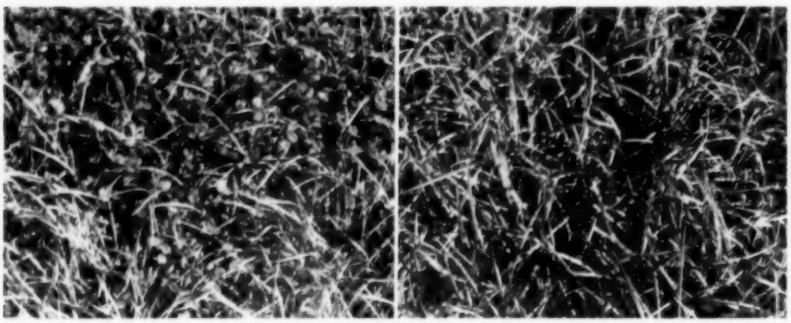


Figure 10.—*Nitrogen on legume-grass mixtures.* Heavy nitrogen application on legume-grass mixtures will probably increase production; however, the legumes are crowded out by the vigorously growing grass.

Left: Third year ladino-orchard grass which has had adequate lime, phosphorus and potassium.

Right: Identically treated pasture as above except for 200 pounds of nitrogen per acre per year (in four 50-pound applications). Note the lack of legumes in the pasture which has been heavily fertilized with nitrogen.

fertilizer efficiency on these soils, the potash should be split into two or more annual applications.

Need for nitrogen

A pasture cannot be high-yielding unless large quantities of nitrogen are available for rapid plant growth. Nitrogen can be provided by legumes or commercial fertilizers.

In most situations, legume-grass mixtures should be used to the maximum. As long as the pasture mixture contains about 50 per cent or more vigorous legume plants, commercial nitrogen normally should not be applied to the pasture, even though it probably would increase that year's production. Nitrogen fertilizer stimulates the grasses which in turn suppress the legumes and hasten their disappearance from the pasture. If the pasture is part of the crop rotation and is to be plowed at the end of the grazing season or the following spring, nitrogen fertilizer might be applied even though the legume stand is good.

When the stand declines below about 50 per cent legume nitrogen fertilizer should be used liberally. On orchard grass economical yield increases have been obtained with up to 200 pounds of nitrogen per acre

Figure 11.—*Nitrogen on orchard grass and timothy.* These plots receive nitrogen at the rate of 200 pounds per acre per year in four applications. Particularly after the first cutting or grazing, orchard grass (left) uses nitrogen more efficiently than timothy (right). The arrows on the stake give the height of the grass in July after the first harvest.

per year applied in 3 or 4 applications. Almost as much nitrogen can be used economically on Saratoga smooth bromegrass, but somewhat less nitrogen should be applied to other bromegrass varieties, timothy, or Kentucky bluegrass. The cost of this amount of nitrogen fertilizer usually exceeds the cost of providing the proper growing conditions for legume-grass pastures. In most situations nitrogen should be used liberally as a supplement to legume-grass pastures, but not as a complete substitute for legumes. To obtain high yields of grass year after year from nitrogen fertilizer, potash also must be applied frequently. Grasses require slightly less phosphorus than legumes but periodic applications of phosphate fertilizer are required.

Minor elements

Few soils in New York State require minor element additions for forage crops. Sandy soils may require boron for maximum yields of alfalfa. If deficiency symptoms appear, apply 20 pounds of borax per acre or use fertilizer containing borax. Magnesium is sometimes deficient in some very strongly acid soils, but adequate liming usually corrects these low magnesium levels.

Grazing Management

The best lime, seed and fertilizer program is of little value if the pasture is not properly managed. Without good management the forage will not be effectively utilized and the legumes may be lost or greatly reduced in vigor. Most legumes require careful management if they are to remain productive. Others like Empire birdsfoot trefoil can survive under a wide range of management practices.

One thing must be recognized: no pasture is uniformly productive throughout the growing season (figure 12). Two to 4 times as much grazing area is required in late July and August to provide the same amount of feed as in late May and early June. The pasture area must be adjusted to this seasonal variation.

Continuous grazing

Continuous grazing of one large pasture is wasteful. The grazing animals prefer young tender forage and will eat this type of material as long as it is available. When livestock are first turned into lush growth of forage there is little selective grazing; all of the forage is palatable and nutritious. In a large pasture the animals cannot consume all of the forage before the uneaten forage becomes coarse and unpalatable. Animals refuse to eat this material and go back to regrowth on areas they have previously grazed. Within a few weeks the pasture is badly overgrazed in some spots and sadly undergrazed in other areas. Tall-growing legumes may be weakened and eliminated in the closely grazed areas because of too frequent defoliation. Also, they may be crowded out by competition from

Figure 12.—*Seasonal production of different types of pastures and pasture mixtures.*

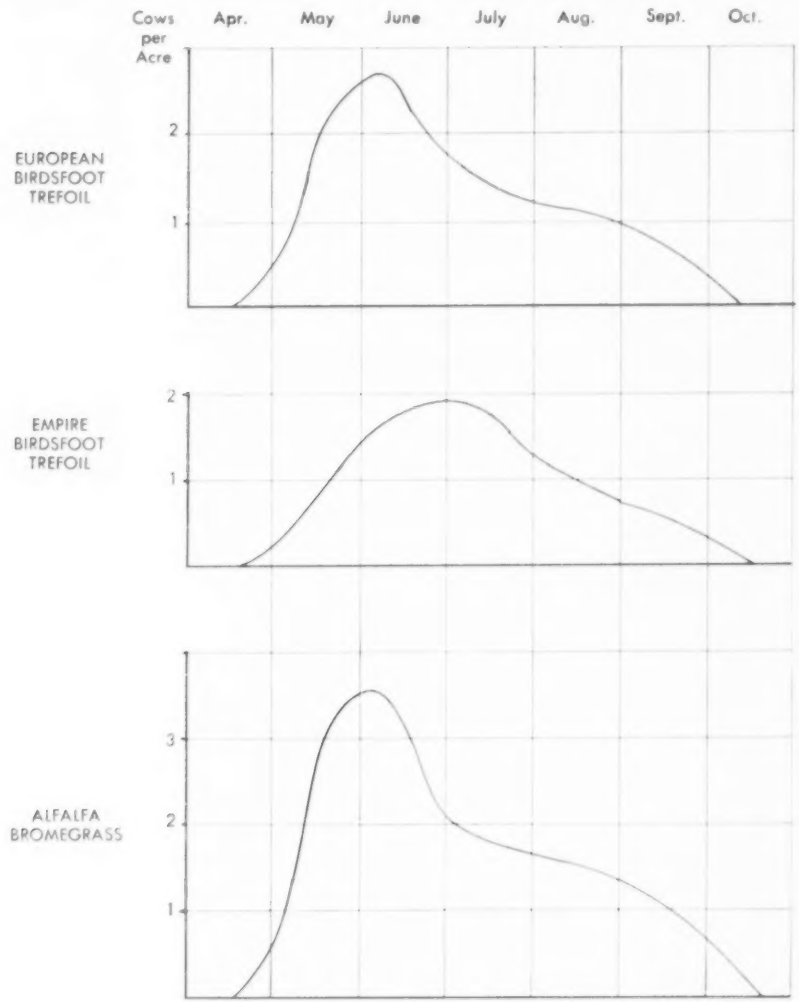


Figure 12.—*Seasonal production of different types of pastures and pasture mixtures.*

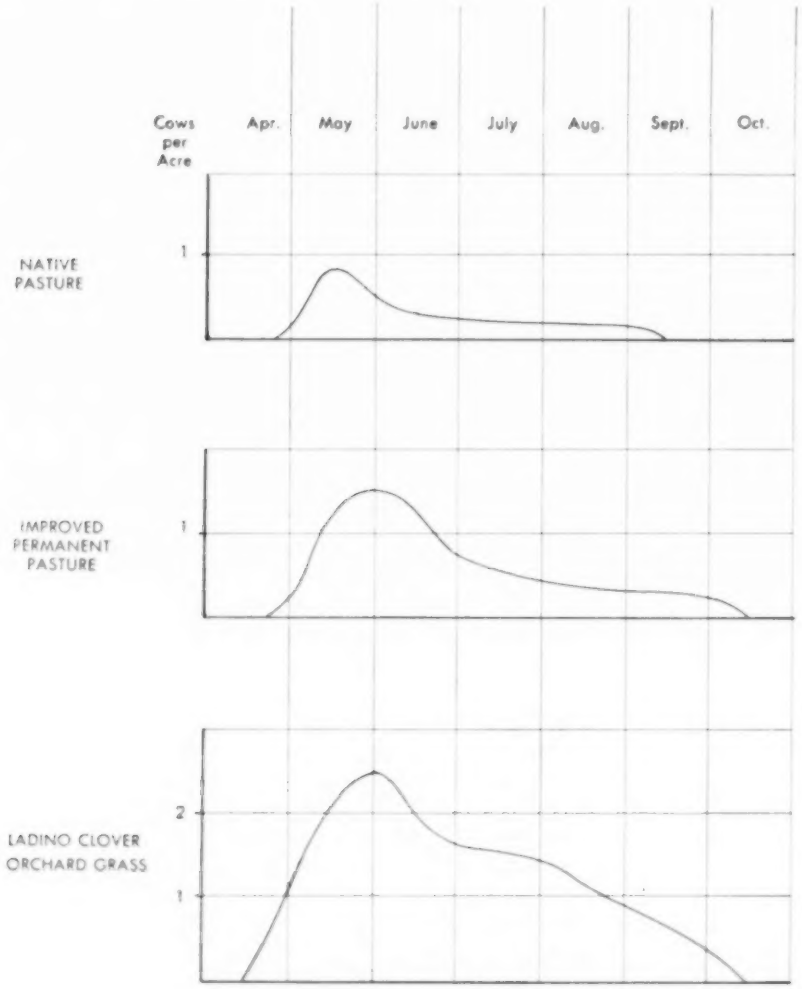


Figure 13.—*Overgrazing and undergrazing in the same pasture.* Understocking a pasture results in excess forage becoming unpalatable causing animals to graze regrowth of previously grazed areas. This results in areas within a single pasture which are undergrazed (left foreground) and other areas which are overgrazed (center).

the grasses in the undergrazed areas. Frequently the animals graze less than half of the pasture area.

Kentucky bluegrass-wild white clover and Empire birdsfoot trefoil pastures perform reasonably well under semi-continuous grazing. Large areas should be divided into two or three pastures. Animals should graze one pasture for several weeks then be shifted to another one. Some under- and over-grazing will occur but both Kentucky bluegrass-wild white clover and Empire birdsfoot trefoil pastures will persist under this type of management. Further division of the pastures would result in more efficient utilization of the forage, but the gain in production frequently will not offset the additional cost of fencing and management.

Rotational grazing

Rotational grazing is highly desirable for ladino clover-grass mixtures and essential for alfalfa and

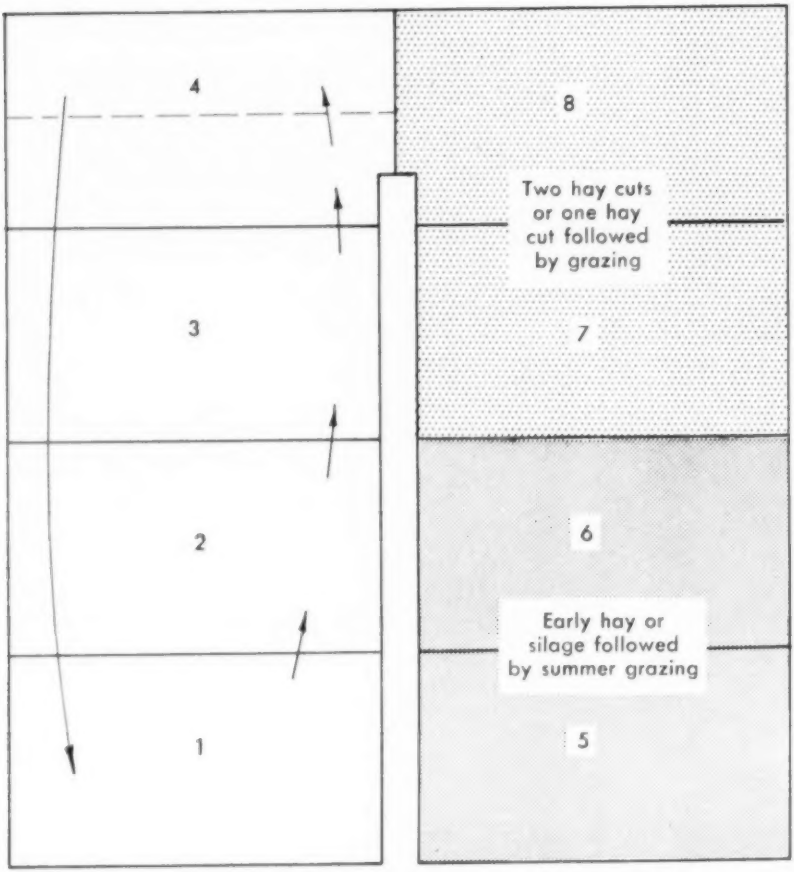


Figure 14.—Rotational grazing plan for a 40-cow herd on a 40-acre alfalfa-bromegrass pasture. The pasture is divided into eight 5-acre paddocks. Each paddock is grazed in turn and the excess forage harvested as indicated. The paddocks can be again divided by a temporary fence in periods of extremely fast growth to avoid having animals on the same area longer than 7 days.

European birdsfoot trefoil. For ladino clover good rotational grazing can be accomplished by dividing the pasture into 4 to 6 paddocks—each paddock large enough to carry the animals 5 to 7 days. As soon as the animals have consumed most of the available forage, they are shifted to a new paddock.

The forage is allowed to recover for 4 to 5 weeks before regrazing, while the remaining paddocks are grazed in rotation, except that during the flush spring growth period two to three weeks of recovery may be ample. The animals are returned to the first paddock when it is ready even though one or more paddocks have not been grazed. The extra forage can be cut early for silage or hay so that the aftermath production will be available for grazing as pasture production starts to decline (figure 14).

Alfalfa and European birdsfoot trefoil are taller growing and require longer recovery periods than ladino clover. To prevent damage to the forage crop, the pastures should be grazed off in 7 days or *less* and then be allowed to recover 30 to 45 days. If animals are turned into too large an area of these taller legumes, much forage will be damaged by trampling before the animals can consume it. To prevent waste many small paddocks must be used or a combination of rotational grazing and strip grazing may be used.

Strip grazing

Strip grazing is of most value when tall-growing crops are grazed. The field can be divided into 6 to 8 paddocks with each paddock large enough to carry the animals for 5 to 7 days. Rather than allow the animals to run over the entire paddock and cause heavy trampling losses, a movable cross fence is used to restrict the grazing area to what the animals will consume in 12 or 24 hours.

The animals may be confined to this narrow strip of fresh forage by using two cross fences but this generally creates a watering problem. For most situations a single cross fence is used and moved once or twice each day. The cattle go back across the grazed area for water and shade. If the paddock is small enough that all of the forage can be consumed within a week, regrazing the new growth will not be serious.

"Zero" grazing

Trampling losses are relatively high for the taller growing pasture plants even when strip grazing is practiced. The only way to eliminate such losses is to harvest the forage and feed it in the barn or feed-lot. The field-chopper makes this practice possible, but the farmer should carefully weigh the advantages and disadvantages before adopting this practice.

Figure 15.—*Strip grazing.* These cows are on an alfalfa-ladino-bromegrass pasture and are given a fresh area to graze each day by a single movable electric fence. They have just moved onto the new area; the location of the fence on the previous day is shown in the foreground by the grazed and ungrazed forage.

Advantages of "zero" grazing:

1. Losses from trampling and manure contamination are eliminated.
2. Carrying capacities of the taller-growing pasture crops are increased by 25% or more.
3. Fencing and watering costs are reduced.
4. Managing the animals requires less time.
5. There is some reduction in the energy requirement of the animals.

Disadvantages of "zero" grazing:

1. Animals must eat the whole plant rather than the more nutritious parts through selective grazing. Production per animal may be reduced if the forage becomes too mature.

Figure 16.—*"Zero" grazing.* Tall-growing forage plants such as these are necessary for a "zero" grazing program.

2. Chopped forage often heats and becomes unpalatable to some animals. Frequently the forage must be harvested twice a day or consumption is reduced.
3. There is no yield advantage for ladino clover and other lower growing pasture plants. In dry seasons 2nd and 3rd growth of alfalfa may be too short for "zero" grazing.
4. Labor and machinery for harvesting the pasture may compete with other farm operations. Also, it is an additional chore that must be done 7 days a week.
5. Spare machinery or supplemental pasture must be available in case of equipment breakdown.

"Zero" grazing is most likely to be profitable on the few farms where the pasture land is suitable for alfalfa or the intensive growth of tall annual crops, such as Sudan grass, millets, sorghums or corn for green feeding. On farms where some of the pasture land is in tall-growing crops the field-chopper can be used to harvest these crops for feeding as a supplement to the pastures being grazed. This system of management prevents undue wastage of the taller-growing pasture crops and at the same time overcomes some of the disadvantages of a complete "zero" grazing program. Animals have forage available for grazing in case of equipment breakdown and during peak labor and equipment demands. There appears to be little advantage for

"zero" grazing except when alfalfa or tall-growing annual crops are to be used for pasture.

Mowing Pastures

Uneaten forage and weeds should be mowed a day or two prior to removing the animals from the pasture. Much of the mowed forage will be eaten unless very mature or chiefly weeds. If not mowed, the weeds are likely to set seed and the forage will become coarse and unpalatable. Soil moisture and nutrients will be used to produce this unwanted growth instead of nutritious pasture.

A pasture should be mowed at least once and generally twice a season—once to cut off unpalatable forage that has escaped grazing in the spring and again in late summer for weeds. If the pastures are adequately stocked, the animals will consume most of the forage; and more frequent mowing, even though it improves the appearance, probably is not economical or essential. When pastures are undergrazed, frequent mowing is necessary or much of the pasture will be covered with unpalatable, poor quality, mature forage.

Scattering Droppings

Animals do not readily graze the forage around fresh droppings. Scattering the droppings with a flexible grass harrow or similar equipment

Figure 17.—*Pasture mowing.* This is the first year of grazing on this pasture. It should be mowed to control the weeds.

makes for more uniform grazing of the pasture, but no data are available on the costs and returns. On very productive pastures with high carrying capacities, the accumulation of droppings is likely to reduce forage utilization. Scattering them at the time of mowing may be advisable on high-producing pastures.

Irrigation

It is a rare summer during which rainfall is sufficient or properly distributed for maximum plant growth. For this reason supplemental irrigation may appear to be the solution to the midsummer slumps in pasture growth. On the other hand, irrigation equipment requires a sizeable outlay of cash. A farmer should consider carefully the costs and benefits of irrigation before making such an investment.

In most years irrigation will improve moisture conditions for plant growth. But the fact is frequently overlooked that much of the increase in growth may be due to greater succulence rather than increased dry matter yield (figure 18). In south central and eastern New York, where summer rainfall is 18 inches or higher, irrigation has resulted in little or no increase in yield of forage dry matter. In north central and west central New York, where summer rainfall is below 18 inches, irrigation of excellent pastures has increased the yield of dry matter by about one ton per acre.

In addition to increasing the yield of forage in certain areas of the State, irrigation improves the palatability and possibly the digestibility of the forage. This improvement in quality appears to be important for dairy cows but of less value to growing or fattening animals.

An adequate amount of near-by water which requires little or no cost to develop is essential. Pastures will not support the cost of irrigation equipment plus the cost of developing a water supply. A tremendous amount of water is needed for irrigation. Each acre-inch contains 27,000 gallons. Because evaporation and other losses occur, about 40,000 gallons of water should be available for each acre-inch actually applied to the land. Pastures should be irrigated at least three or four times a season for a total water application of 4½ to 6 inches of water. To apply 6 inches of water, a quarter of a million gallons must be available for each acre to be irrigated. It is not profitable to buy irrigation equipment for a unit smaller than 10 acres. Do not purchase irrigation equipment unless the source of water will supply at least 2 to 2½ million gallons of water in a *dry season*.

General considerations before purchasing an irrigation system

1. It is doubtful if investment in irrigation equipment for forage crops alone will pay on silt loam and finer textured soils except in the drier regions of the State, such as the west-

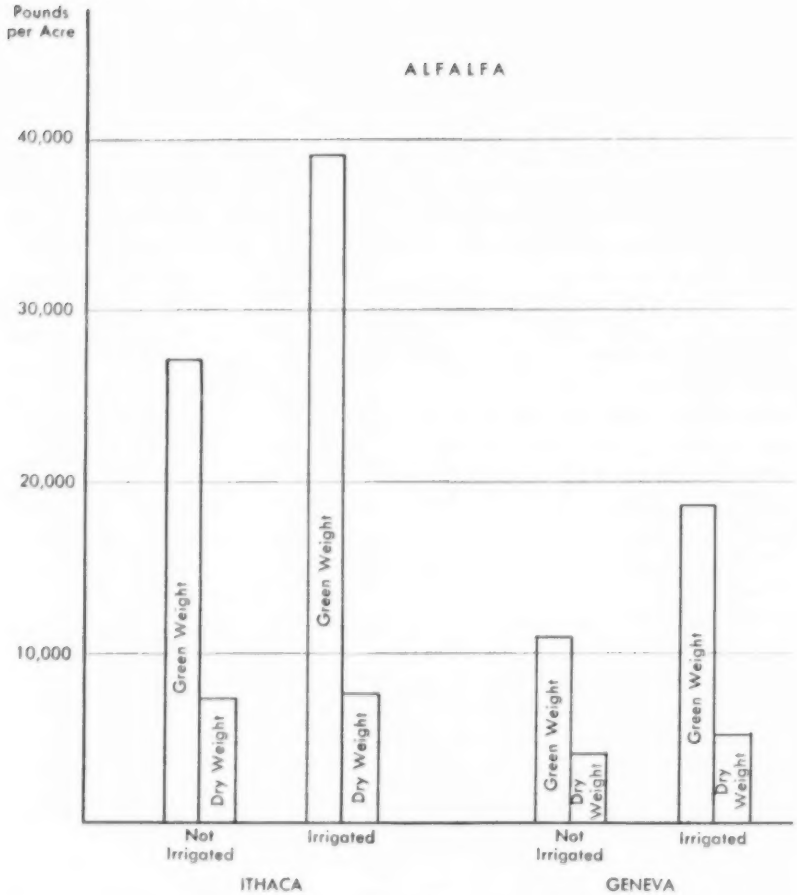


Figure 18.—*The Effect of Irrigation on Alfalfa.* The apparent response of forage crops in New York to irrigation is largely due to increased water content or succulence of the forage; in most cases the increase in dry matter is much less than the lush growth would indicate.

ern counties. Irrigation is most likely to pay on an excessively drained gravelly or sandy soil. It may be profitable on some of the shallow soils with an effective rooting zone of 10 to 20 inches.

2. Irrigation will often increase the yields of good stands of high-yielding mixtures, but even on deep sandy soils unirrigated alfalfa-grass mixtures will yield nearly as much as irrigated ladino-grass mixtures. Grow alfalfa wherever possible on well-drained, droughty soils.

3. Adequate liming and good fertilizer practices usually increase pasture production for less money than will irrigation. If lime and fertilizer are properly used with the right crops, irrigation may not be needed.

4. Be sure the source of water is adequate for a dry season. Have it checked by a person who can make a reliable estimate before investing in equipment.

5. An irrigation system must be designed for the individual situation. Obtain assistance from a qualified person. Avoid buying a packaged unit.

6. Consider all the alternatives for providing summer feed before deciding on irrigation. Irrigation of forage crops has a place in New York State, but on many farms it is not the most economical method of providing extra forage.

Supplementary Pasture

Under the most favorable moisture and fertility conditions, the summer production of a pasture is only about one-half of that obtained during the flush period of late spring. Under less favorable conditions, a relatively good pasture may produce only one-fourth as much feed in late summer as in late spring. To offset this seasonal decline a farmer may: 1) feed hay, silage, or chopped green feed; 2) increase the pasture acreage by grazing second growth of previously harvested meadows or pastures; 3) grow summer annual crops, such as millet or Sudan grass; 4) increase summer production of pastures by irrigation or by the liberal use of delayed applications of nitrogen fertilizer on orchard grass pastures. Each farmer must determine what method or combination of methods for providing summer feed is best suited to his farm.

First consideration should be given to increasing the summer production of the hay and pasture crops through the use of improved varieties and mixtures, good management, and adequate lime and fertilizer. Maximum use should be made of deep-rooted legumes whenever soil conditions permit.

Sudan grass produces excellent summer pasture in central and southern New York. The millets are more

suitable for elevations above 2,000 feet and in northern New York. The cost of producing these annual crops, however, should not be ignored. Land must be plowed, fitted and seeded each year. In New York State the growing season is so short that it is rarely possible to grow a profitable second crop on the land in the same year. The land used to grow Sudan grass might have produced a crop of corn. Corn will produce more TDN per acre than Sudan grass with a relatively small increase in cost of production.

Sudan grass is sometimes used as a companion crop when seeding pastures and meadows. When so used, part of the cost of growing the crop can be charged against the seeding. Sudan grass or the millets are competitive with the new seeding and must be grazed rather than used for silage or hay. The use of Sudan grass or the millets as companion crops must be limited to sites with unusually favorable moisture conditions. Additional information on Sudan grass may be obtained from Cornell Extension Bulletin 798, *Sudan Grass for Pastures*.

As with irrigation, farmers should consider other alternatives for providing summer feed before deciding to rely upon Sudan grass or the millets. In certain situations these crops are first choice; in many other situations cheaper summer feed can be obtained by better management of the perennial forage crops.

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